FINAL SURVEY REPORT ON

ERGONOMICS INTERVENTIONS

FOR SHIP CONSTRUCTION PROCESSES

at

MARINETTE MARINE SHIPYARD,
Marinette, Wisconsin

REPORT WRITTEN BY:
Stephen D. Hudock, Ph.D., CSP
James T. Albers, M.S., CIH

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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Organizational Science and Human Factors Branch
4676 Columbia Parkway, Mailstop C-24
Cincinnati, Ohio 45226

PLANT SURVEYED:	Marinette Marine shipyard, Manitowoc Company, Inc., 1600 Ely Street, Marinette, Wisconsin 54143-2434.
SIC CODE:	3731
SURVEY DATE:	May 8-9, 2000
SURVEY CONDUCTED BY:	Stephen D. Hudock, NIOSH Steven J. Wurzelbacher, NIOSH (now with Mitsui-Sumitomo Loss Control)
EMPLOYER REPRESENTATIVES CONTACTED:	as of May 2000: Bill Getchell, Safety Director, Marinette Marine
EMPLOYEE REPRESENTATIVES CONTACTED:	Milan Racic, Health and Safety Specialist, International Brotherhood of Boilermakers, Iron Ship Builders, Blacksmiths, Forgers, and Helpers (IBB); Mike Tanguay, Lodge 696 Bargaining Committee Chair, IBB

DISCLAIMER

Mention of company names and/or products does not constitute endorsement by the Centers for Disease Control and Prevention (CDC).

ABSTRACT

A pre-intervention quantitative risk factor analysis was performed at various shops and locations within Marinette Marine, as a method to identify and quantify ergonomic risk factors that workers may be exposed to in the course of their normal work duties. The application of exposure assessment techniques provided a quantitative analysis of the risk factors associated with the individual tasks. Based on these analyses, four ergonomic interventions were suggested for Marinette Marine: 1) wheeled, adjustable work stools and knee supports for engine room and lifeboat rack welders, torch cutters, and grinders, 2) a rotating/tilting weld positioner for the tripod assembly welding process 3) worker awareness training in the sheetmetal shop and 4) come-alongs requiring the lowest maximum pull for a given capacity, with capacity appropriate to the shipfitting tasks performed. Of these interventions, it was expected that the wheeled, adjustable work stools/ knee supports and the rotating/tilting weld positioner would have had a significant impact on reducing musculoskeletal injuries. The actions taken to address the implementation of these interventions are documented in this document.

I. INTRODUCTION

IA. BACKGROUND FOR CONTROL TECHNOLOGY STUDIES

The National Institute for Occupational Safety and Health (NIOSH) is the primary Federal agency involved with occupational safety and health research. Since 1976, NIOSH has conducted a number of assessments of health hazard control technology on the basis of industry, common industrial process, or specific control techniques. The objective of each of these studies has been to document and evaluate effective control techniques for potential health hazards in the industry or process of interest, and to create a more general awareness of the need for, or availability of, an effective system of hazard control measures. Initially, a series of walk-through surveys are conducted to select plants or processes with effective and potentially transferable control technology concepts or techniques. Next, in-depth surveys are conducted to determine both the control parameters and the effectiveness of these controls. The reports from these in-depth surveys are then used as a basis for preparing technical reports and journal articles on effective hazard control measures. Ultimately, the information from these research activities will build a database of publicly available information on hazard control techniques for use by health professionals who are responsible for preventing occupational illness and injury.

IB. BACKGROUND FOR THIS STUDY

The background for this study may be found in the previous reports: 1) EPHB Report No. 229-14a, "Preliminary Survey Report: Pre-Intervention Quantitative Risk Factor Analysis for Ship Construction Processes at Marinette Marine Corporation Shipyard, Marinette, WI" by Hudock and Wurzelbacher, 2001a, and 2) EPHB Report No. 229-14b, "Interim Survey Report: Recommendations for Ergonomics Interventions for Ship Construction Processes at Marinette Marine Corporation Shipyard, Marinette, WI" by Hudock and Wurzelbacher, 2001b. Both of these reports are available on the NIOSH website:
http://www.cdc.gov/niosh/ergship/reports.html.

IC. BACKGROUND FOR THIS SURVEY

The Marinette Marine facility was selected for a number of reasons. It was decided that the project should look at a variety of yards based on product, processes and location. Marinette Marine is one of the U.S. Coast Guard's leading suppliers of large vessels. Marinette Marine builds two sizes of buoy tenders for the Coast Guard. The Marinette Marine facility is considered to be a medium to small shipyard.

II. PLANT AND PROCESS DESCRIPTION

IIA. INTRODUCTION

Plant Description: The Marinette Marine shipyard is located in Marinette, Wisconsin on the south shore of the Menominee River that separates Wisconsin from the Upper Peninsula of Michigan. The river flows into the northern part of Green Bay that in turn opens onto Lake

Michigan. The 60-acre yard includes about 500,000 ft^2 of enclosed workspace including large fabrication shops and enclosed unit erection areas.

Corporate Ties: Marinette Marine was acquired by Manitowoc Company, Inc. in November 2000 and is now part of the Manitowoc Marine Group, which also includes Bay Shipbuilding Co., Toledo Shiprepair Co., and Cleveland Shiprepair Co.

Products: Marinette Marine is under contract to the U.S. Coast Guard to manufacture both 225'-long seagoing buoy tenders and 175'- long coastal buoy tenders. In addition, the shipyard has recently completed lodging barges for the U.S. Navy, and is building ferries for the Staten Island to New York City traffic.

Age of Plant: The facility has been in operation since 1942. The main buildings appear to be no more than twenty years old.

Number of Employees, etc: As of the date of the survey, the Marinette Marine facility employed approximately 650 workers.

IIB. SELECTED PROCESS DESCRIPTIONS

Five specific processes were identified for further analysis. These processes were: engine room wire welding, tripod subassembly wire welding, life boat rack assembly, sheet metal duct assembly, and assembly shipfitting using a come-along. Each of these processes was examined in greater detail in the preliminary and interim reports (Hudock and Wurzelbacher, 2001a and 2001b) and is summarized below.

IIB1. Engine Room Wire Welding Process

Onboard the vessels under construction, steel structures, whether they are units or subassemblies, must be welded together to form a more complete product. Depending on the location of the work, and the size and training of the individual, the worker may be exposed to constrained and awkward postures. The work may be at or below deck level, on the bulkhead, or over the worker's head. Often one or more other workers are in the vicinity performing their job duties that may or may not be similar to those of the welders.

IIB2. Tripod Subassembly Wire Welding in Shop Process

Small subassemblies are brought to this location to be welded together or to add additional pieces of steel to the subassembly. A dedicated workstation is provided for the worker to perform these tasks. A number of jigs are available to hold the work piece and saw horses and small tables are available to place the work piece on. The worker must perform the job from a variety of postures, including seated, standing bent over the work, or kneeling. Occasionally, the worker must turn the work piece over or adjust its position so that the worker can more easily weld or grind a particular seam. If the worker needs to move the subassembly on or off the workstation, the worker may rig it to be lifted by one of the hoists available in the shop area.

IIB3. Life Boat Rack Assembly Process

As each vessel nears completion, the upper deck is fitted with lifeboat racks from which the boats can be launched in time of need. The worker is required to perform a number of tasks at or near deck level. The frames are composed of a number of angle irons that are torch cut to exact size and ground smooth on the edges. The angle irons are then moved into their places on the deck by hand where they are welded into place on the deck. Adjustment of rack position is occasionally made by sledgehammer, especially if part of the rack has already been welded to the deck.

IIB4. Sheetmetal Assembly in Shop Process

Ventilation ductwork and other sheet metal subassemblies are built within the fabrication shops as much as possible. The sheet metal is formed to shape and then fit together. The worker must move the subassembly around on the fixed height worktable to get to necessary work locations.

IIB5. Assembly Fitter Using Come-along in Shop Process

The shipfitter must torch cut, grind and weld angle iron, steel plate and other materials into place so that subassemblies can be matched and secured exactly in place. The shipfitter uses a variety of tools in the performance of the job and must be very exact in the task, inspecting it frequently. Often the pieces can be forced into place by using come-alongs to maintain force to hold the steel in its proper position and then the subassemblies are welded together.

III. CONTROL TECHNOLOGY

The following section presents various ergonomic interventions that are suggested for implementation at Marinette Marine. These suggestions are based on the risk factor analysis that was performed at Marinette in May of 2000 and detailed in a previous NIOSH report (EPHB Report No. 229-14a, Hudock and Wurzelbacher, 2001a) available on the NIOSH website at: http://www.cdc.gov/niosh/ergship/reports.html.

IIIA. Possible Interventions for the Engine Room Wire Welding Process and Life Boat Rack Assembly Process

Whenever a worker has to kneel or squat for long periods of time to conduct their work, it is suggested that adequate stools or benches be provided which allow the worker to sit to lessen the stress on the knees and on the lower back. These seats may be useful for mostly level, non-confined areas of the engine room or up on deck. Four-wheeled seat carts and high quality knee pads were provided for use as interventions for this process. Upon follow-up with the shipyard, neither of the items were in use in the same operations as originally intended. It was determined that this lack of initial use was primarily due to lack of worker acceptance and difficulties in making the interventions work in the chosen processes. Therefore, no appraisal of the effectiveness of these interventions as originally intended is possible.

IIIB. Possible Intervention for the Tripod Subassembly Wire Welding in Shop Process

Currently, the worker in the tripod subassembly area must perform the job from a variety of postures, including seated, standing bent over the work, or kneeling. The welder must also occasionally manually reposition the weldment and weld in positions other than flat. Thus, an intervention such as a tilting, rotating weld positioner may offer a solution both to eliminate the risk factor of awkward postures required for the job and to increase the efficiency and quality of the weld job. At the time of this report, the shipyard had not yet implemented this intervention.

IIIC. Possible Interventions for the Sheetmetal Assembly in Shop Process

If feasible, sheetmetal workers should use bench-mount hand brakes, and metal forming presses/ machines rather than hammers, hand seamers, and hand crimpers. For the most part, Marinette sheetmetal workers did have access to these types of machines. Thus, worker awareness training about the ergonomic benefit of these machines may be required to entice the workers to make use of the available equipment.

IIID. Possible Interventions for the Assembly Fitter Using Come-along in Shop Process

The come-along (lever-operated chain or wire rope devices designed for pulling) is a common shipfitting tool that can require the operator to produce pulls up to 100 lbs. The required pull depends on the brand and load capacity of the come-along and most manufacturers will provide maximum required pull information. Workers should use the lowest possible capacity puller to do the job and tool personnel should take the tool's required pull into consideration when purchasing new come-alongs. Brands with lower maximum required pulls are generally slightly more expensive for a given capacity and length.

IV. CONCLUSIONS

Five distinct construction processes were examined at Marinette Marine to quantify the musculoskeletal risk factors associated with these processes. The processes included: engine room wire welding, life boat rack assembly, tripod subassembly wire welding, sheetmetal assembly, and assembly fitting using come-along. Based on ergonomic task analyses, four ergonomic interventions are suggested for at Marinette Marine: 1) wheeled, adjustable work stools and knee supports for engine room and lifeboat rack welders, torch cutters, and grinders, 2) a rotating/ tilting weld positioner for the tripod assembly welding process 3) worker awareness training in the sheetmetal shop and 4) come-alongs requiring the lowest maximum pull for a given capacity, with capacity appropriate to the shipfitting tasks performed. Of these interventions, it was expected that the wheeled, adjustable work stools would have had a significant impact on reducing musculoskeletal injuries. Unfortunately, the materials supplied for the intervention were not well accepted in the proposed work areas and not fully implemented. Therefore, the effectiveness of the interventions could not be determined. Additionally, the safety manager and primary site contact at the time of the quantification visits and intervention selection phases is no longer with Marinette Marine, making follow-up on the interventions difficult at best.

It is suggested that further action can be taken to mitigate the exposure to musculoskeletal risk factors within each of the identified tasks. The implementation of engineered ergonomic interventions has been found to reduce the amount and severity of musculoskeletal disorders within the working population in various industries.

Each of the interventions proposed in this document are to be considered preliminary concepts. Full engineering analyses by the participating shipyard are to be expected prior to the implementation of any particular suggested intervention concept to determine feasibility, both financial and engineering, as well as to identify potential safety considerations.

V. REFERENCES

Hudock, S. D., and S. J. Wurzelbacher. Preliminary Survey Report: Pre-Intervention Quantitative Risk Factor Analysis for Ship Construction Processes at Marinette Marine Corporation Shipyard, Marinette, WI. DHHS, PHS, CDC, NIOSH, Cincinnati, Ohio, Report # EPHB 229-14a, August 2001, 94 pp. Available on the NIOSH website: http://www.cdc.gov/niosh/ergship/reports.html.

Hudock, S. D., and S. J. Wurzelbacher. Interim Survey Report: Recommendations for Ergonomic Interventions for Ship Construction Processes at Marinette Marine Corporation Shipyard, Marinette, WI. DHHS, PHS, CDC, NIOSH, Cincinnati, Ohio, Report # EPHB 229-14b, August 2001, 30 pp. Available on the NIOSH website: http://www.cdc.gov/niosh/ergship/reports.html.